"Towards Global Technical Excellence"

A Project Report On

FruitSack : AI-Driven Fruit Pricing

Submitted to Sant Gadge Baba Amravati University, Amravati in Partial Fulfillment of The Requirements for the Degree of BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND ENGINEERING

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Final Year
(2022-23)

"Towards Global Technological Excellence" **GOVERNMENT**

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CERTIFICATE

This is to certify that the project entitled "**FruitSack : AI-Driven Fruit Pricing** ", which is being submitted herewith for the award of B.Tech, is the result of the work completed by the following under my supervision and guidance within the four walls of the institute and the same has not been submitted elsewhere for the award of any degree.

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DECLARATION

We undersigned the students of Bachelor of Technology in Computer Science and Engineering at Government College of Engineering Amravati declare that the major project work entitled "FruitSack : AI-Driven Fruit Pricing " is the outcome of my own work and has been carried out taking care of engineering ethics. This work has not infringed any patented work and has been submitted to other University or elsewhere for the award of any degree or professional diploma to the best of my knowledge.

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ABSTRACT

In this project, we proposed online fruits market in which fruit sellers will be able to do registration and register their fruits for selling. Customers will browse fruits of different sellers and place order as per the requirement. The sellers will receive orders. They will process pending orders. But generally customers avoid placing order of vegetables or fruits online as the products feels fresh in images but get rotten when received. Therefore to avoid this problem we proposed fruits quality based price calculation system using machine learning.

Deep learning has progressed significantly in recent years, making it an ideal choice for image processing applications. Recognition and classification of fruits using deep learning are considered as the most promising techniques for commercial and agricultural applications. Despite this, the researchers are still having difficulty in distinguishing fruits due to their similar colour, shape, size.

We proposed machine learning model using Convolutional Neural Network. Convolutional Neural Network, also known as convnets or CNN, is a well-known method in computer vision applications. It is a class of deep neural networks that is used to analyze visual imagery. This type of architecture is dominant to recognize objects from a picture or video. It is used in applications like image or video recognition, neural language processing, etc. Along with fruit quality detection, we also proposed price calculation algorithm. User will upload some of the purchased fruits and specify their details, e.g. if user purchase 2 kg apple amongst them 2-3 apples are rotten and remaining apples are fresh so the price will be calculated accordingly.

Keywords: Machine Learning, Convolutional Neural Network, Computer Vision, Deep Neural Networks.

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LIST OF ABBREVIATIONS

Sr. No	Abbreviations	Expanded Form
1.	CNN	Convolutional Neural Network
2.	CMOS	Complementary Metal-Oxide-Semiconductor
3.	RGB	Red, Green And Blue
4.	CIE	Commission Internationale De L´Eclairage
5.	HSI	Hue Saturation Intensity
6.	HSV	Hue Saturation Value
7.	FC	Fully Connected
8.	ReLU	Rectified Linear Unit

Chapter 1

INTRODUCTION

1.1 Overview

Nowadays mostly people prefer online shopping for daily need products as well as for fruits and vegetable purchase. But sometimes customer get poor quality fruits or vegetables and they can't do anything once order processed. Therefore to solve this problem we proposed online fruits shopping and fruits quality wise price calculation system using machine learning algorithms. We proposed CNN algorithm for fruits quality prediction.

In today's world, everything in agriculture is getting automated and manual interference in the system becomes non-commercial solution as well as time consuming task. The quality of fruit must be checked before it is used for making food products. In agriculture, the quality of fruit is somewhat dependent on the water availability, soil type, proper usage of fertilizers, etc. In old days, more manpower is required used for selection of quality fruits and vegetable for the production purpose in industries. In recent years many automated systems were invented and that are used for identification of quality fruits.

The existing system finds the quality of fruits and displays the message as good or rotten fruit which uses K-means algorithm of supervised learning technique, as it takes more time to predict the fruits quality with an average accuracy of 94.12%. Our proposed system is capable of finding the quality of fruit by using the classification algorithm of supervised learning technique in a short span of time with high accuracy. These features are used to classify the fruits into different categories like good, moderate and rotten fruits. Machine vision technique uses conventional neural network algorithm to predict whether the fruit quality is good, moderate or rotten.

The Convolutional Neural Network (CNN) is trained with good, moderate and rotten images of apple, orange and banana, so that it can predict whether it is good or rotten. Artificial neural network is the extension of many classification techniques. It classifies the fruits by using the shape, color and size features provided at the time of training and also the extracted features of fruit and provides the result by comparing these features. Finally, the fruits are categorized as a good, moderate and rotten one.

1.2 Objectives

The aim of the Fruits Quality based Price Calculation System using Machine Learning project is to design and develop a system that can accurately and objectively evaluate the quality of fruits, and provide fair and sustainable pricing for both sellers and buyers in the fruit market. The objectives of the project are as follows:

1. Develop a dataset of fruits with various quality attributes, such as ripeness, firmness, sweetness, and color.

2. Apply machine learning algorithms to the dataset to identify patterns and relationships between fruit quality attributes and their corresponding prices.

3. Design and develop a software system that can take in inputs of fruit quality attributes and provide an accurate and fair price for the fruit based on its quality.

4. Test and validate the system with a variety of fruits and quality attributes to ensure its accuracy and consistency.

5. Evaluate the system's performance and compare it to manual pricing methods to demonstrate its superiority in terms of accuracy, efficiency, fairness, and sustainability.

1.3 Motivation

There are several reasons why a Fruits Quality based Price Calculation System using Machine Learning would be a useful and worthwhile undertaking:

1. Accuracy: Machine learning algorithms have the ability to analyse and process large amounts of data and identify patterns that might not be immediately apparent to human analysts. By incorporating machine learning into a fruits quality-based pricing system, you can achieve a higher level of accuracy in determining the value of a given fruit based on its quality.

2. Efficiency: By automating the process of pricing fruits based on their quality, you can save time and resources that would otherwise be spent on manual evaluation and pricing. This can be particularly important in large-scale

operations, where thousands of fruits may need to be evaluated and priced each day.

3. Fairness: A fruits quality-based pricing system that incorporates machine learning can help ensure that all fruits are priced fairly based on their actual quality. This can help reduce the potential for disputes or conflicts between sellers and buyers, and improve trust and transparency in the fruit market.

4. Sustainability: By accurately pricing fruits based on their quality, you can help reduce waste by ensuring that lower quality fruits are sold at an appropriate price point rather than being discarded or sold at a loss. This can help promote a more sustainable and environmentally-friendly fruit industry.

Overall, a fruits quality-based pricing system using machine learning can help improve the accuracy, efficiency, fairness, and sustainability of the fruit market, making it a valuable project to undertake.

1.4 Scope of Work

Scope of work for "FRUITS QUALITY & PRICE CALCULATION USING DEEP NEURAL NETWORK" includes the following:

1. Data Collection: Collecting data related to fruit quality and price from various sources like farmers, wholesalers, and retailers. The data should include factors that affect the quality of fruits such as size, shape, colour, texture, and taste.

2. Data Pre-processing: The collected data needs to be cleaned, formatted, and processed to remove any missing or inconsistent data. The data may also need to be standardized, normalized, or transformed to be suitable for analysis.

3. Feature Selection: Identifying the relevant features or variables that affect the quality and price of fruits. These features can be selected based on domain knowledge, statistical analysis, or machine learning techniques.

4. Model Selection: Selecting an appropriate deep neural network model that can effectively capture the relationship between the selected features and the quality and price of fruits. The model should be able to handle large and complex

datasets, and be trained using various optimization algorithms.

5. Training and Validation: Training the deep neural network model on the selected features using the collected data. The model's performance should be evaluated using appropriate metrics like accuracy, precision, recall, and F1-score. The model should be validated using cross-validation techniques to ensure its generalizability.

6. Testing and Deployment: Testing the trained deep neural network model on unseen data to evaluate its performance. The model can be deployed as a web-based or mobile application, which can be used by farmers, wholesalers, and retailers to estimate the quality and price of fruits based on their features.

1.5 Organisation of Report

Part I: Concepts

This part discusses the important theoretical concepts behind this project.

- Chapter 1.1 introduces the work that has to be done and the methods that are used.
- Chapter 1.2 lists the objectives to be achieved through this work.
- Chapter 1.3 includes the reasons for undertaking of this project.
- Chapter 1.4 states all the work needed to be done for successful implementation, deployment and maintenance of the project.
- Chapter 2 mentions all the papers referred to for creation of this project.

Part II: System Information

This part includes the need for the project and system details.

- Chapter 3 includes the problem statement and the proposed system of the project.
- Chapter 4.1 lists the technologies used to solve the problem statement.
- Chapter 4.2 lists testing done for project.

Part III: Project Implementation

This part includes the implementation of the project using its modules.

- Chapter 5.1 states modules involved.
- Chapter 5.2 states architecture of all components involved.
- Chapter 5.3 includes information on languages and frameworks used.
- Chapter 5.4 shows the work done by the project.

Part IV: Conclusion

Finally, Chapter 6 concludes the project and discusses some future work.

Chapter 2

LITERATURE SURVEY

2.1 Literature Review

The image processing circumvents the problem of processing or quantifying the photographic data mathematically. In “Fruit freshness detection using raspberry pi” International Journal of Pure and Applied Mathematics, Several applications of image processing technology have been developed for the agricultural operations. These applications involve implementation of camera-based hardware systems or color scanners for inputting the images. Fruit classification and fruit disease identification can be seen as an instance of image categorization.

In “ANN based Technique for Vegetable Quality Detection, IOSR Journal of Electronics and Communication Engineering”, ANN was used to classify empire and golden delicious apples based on surface characteristics of the apple images Textural and histogram features are extracted from the images at selected wavelengths. Then, images of apples with surface characteristics were used in classification applications with two cases two class classification and five class classification. Effectiveness of method depend on the correlation between measured feature parameter and quality factor.

In “Fruit Quality Inspection using Image Processing”, Journal of Springer, the algorithm firstly uses k-means algorithm to split the original image into regions based on Euclidean color distance in l*a*b* to produce an over segmentation result. The objective of this work is to develop a general algorithm to effectively segment objects in images to facilitate fruit defect detection. The dimension of feature vectors depends on the numbers of color channel used gray-level based k-means for segmenting images. L*a*b* or CIE-Lab color space is used for k-means clustering.

In “A Review of Non-destructive Detection for Fruit Quality ”, Journal of Springer, Fruit non-destructive detection is the process of detecting fruits inside and outside quality without any damage. CMOS based camera is used for capturing the image. Fruit color is detected according RGB values and fruits are sorted according to color and size. The image can be processed by using MATLAB software. The canny method differs from the other edge detection methods in that it uses two different

thresholds to detect strong and weak edges in the output only if they are connected to strong edge.

In artificial neural network classifies the fruit by comparing shape, color and size provided at the time of training. MATLAB/SIMULINK software used to obtain the result. l*a*b technique is used for color detection in fruits. Calculate RGB parameters and then converted into hue. Color feature extraction algorithm is used to extract the color feature of the image. Convert a RGB image into HIS, HSV, l*a*b and YbCbCr.

In “Fruit Classification System Using Computer Vision”, International Journal of Trend in Research and Development, Color, textural and morphological feature are the most commonly used to identify the disease, maturity and class of the fruits. The computer vision technique include clustering and color based segmentation, artificial neural network and different classifiers based classification of disease. Using digital method, the disease detection can be accurately, time efficient and result in saves time..

2.2 Conclusion

The application is very easy to use for administrator and customers. The administrator will be able to increase the fruits categories and their images in dataset from his web panel. There is a facility to train dataset from web panel only. Customers will upload multiple fruits images at once so finding quality of all the purchased fruits at the same time.

Customers will get the products in affordable and correct cost according to the quality of the fruits. Fruits sellers used to cheat customers by selling low quality fruits along with good quality of fruits. By using this application fruits seller won’t be able to cheat customers. If he tried to do this, he will not get price for low quality fruits.

Chapter 3

SYSTEM ANALYSIS

3.1 Problem Description

The fruit market is often characterized by an inconsistent and subjective pricing system, where fruits are priced based on a variety of factors including their appearance, size, and market demand. This can lead to unfair pricing and the potential for waste, as lower quality fruits may be discarded or sold at a loss. In addition, the manual process of evaluating and pricing fruits can be time-consuming and inefficient, particularly in large-scale operations.

To address these issues, we propose the development of a Fruits Quality based Price Calculation System using Machine Learning. The system would use machine learning algorithms to analyse and evaluate fruits based on a variety of objective quality factors such as ripeness, firmness, sweetness, and colour. By incorporating machine learning, the system would be able to process large amounts of data and identify patterns that might not be apparent to human analysts. This would result in a more accurate, efficient, and fair pricing system, while also promoting sustainability by reducing waste in the fruit market.

Therefore, the problem statement is to design and develop a Fruits Quality based Price Calculation System using Machine Learning that can accurately and objectively evaluate fruits based on their quality, and provide fair and sustainable pricing for both sellers and buyers in the fruit market.

3.2 Proposed System

Compared to Regular Neural Networks, Convolutional Neural Networks have a different architecture. In regular Neural Networks, it transforms an input by putting it through a series of hidden layers. Here every layer is made up of a set of neurons, where each layer is fully connected to all neurons in the layer before. Finally, there is an architecture i.e. a last fully-connected layer — the output layer — that represent the predictions.

There are a bit different in Convolutional Neural Networks. At first, the layers are organized in 3 dimensions: width, height and depth. Here, the neurons in one layer

do not connect to all the neurons in the next layer but only to a small region of it. Lastly, the final output of the system will be reduced to a single vector of probability scores, organized along the depth dimension.

CNN is considered as two major parts:

- **Feature Extraction**

  In feature extraction part, the network will perform a series of convolutions and pooling operations during which the features are detected. If we had a picture of a tiger, this is the part where the network would recognize its pelage, two ears, and four legs.

- **Classification**

  In the case of classification, the fully connected layers will serve as a classifier on top of these extracted features. Here, they will assign a probability for the object on the image being what the algorithm predicts it is. We can understand this in detailed by referencing fig 3.1 as shown below

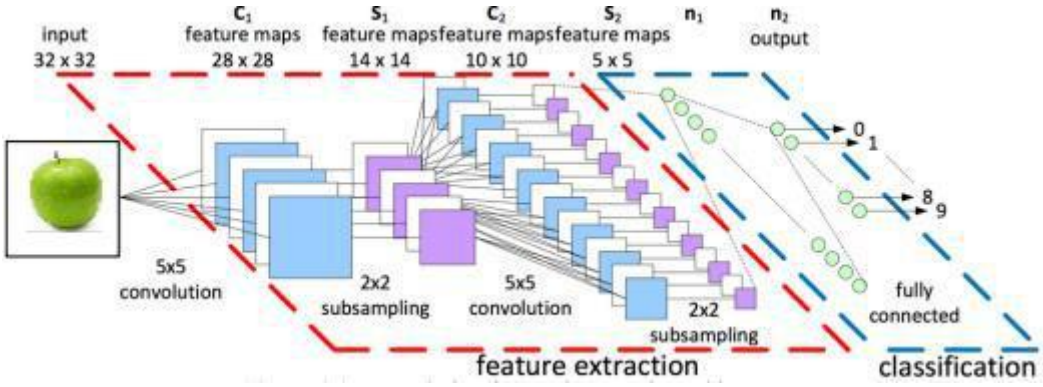


Fig 3.1 Block diagram of Proposed System

Fully Connected Layer (FC Layer) of Classification: Adding a Fully-Connected layer is a (usually) cheap way of learning non-linear combinations of the high-level features as represented by the output of the convolutional layer. In that space, the Fully-Connected layer is learning a possibly non-linear function. Example of CNN is given below by referencing fig 3.2 as shown below

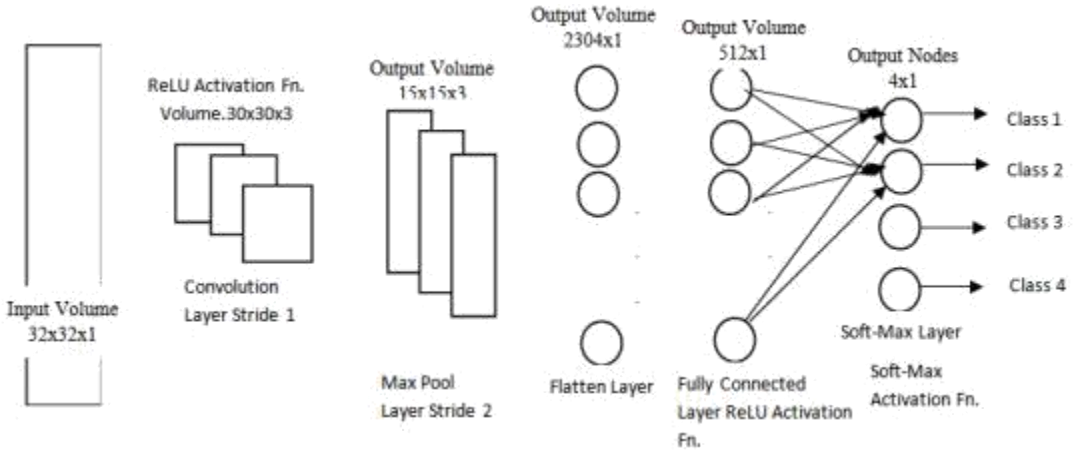


Fig 3.2 Fully connected model

Here, the input images are converted into a suitable form and flatten the image into a column vector. Now the flattened output is fed to a feed-forward neural network and backpropagation applied to every iteration of training. After a series of epochs, the model is able to differentiate between dominating and certain low-level features in images and classify them using the Softmax Classification technique. All the components that are needed to build a CNN: Convolution, ReLU and Pooling. Here the output of max pooling is fed into the classifier which is usually a multi-layer perceptron layer. A block diagram is a short road map for that graphically represents how the data moves through the existing system. The block diagram provides facilitating communication between us and user. It shows the input and output information i.e. what kinds of information will be input to and output from the system, where the data will come from and go to, and where the data will be stored. However it does not show information about the timing of processes but shows the work procedure of the processes.

Chapter 4

TECHNOLOGY AND DEFINED TERMS

4.1 Technologies used for Module Development

- **DBinsertion.py:** This component as shown in the fig 4.1 is the used for collecting and storing dataset that is generated

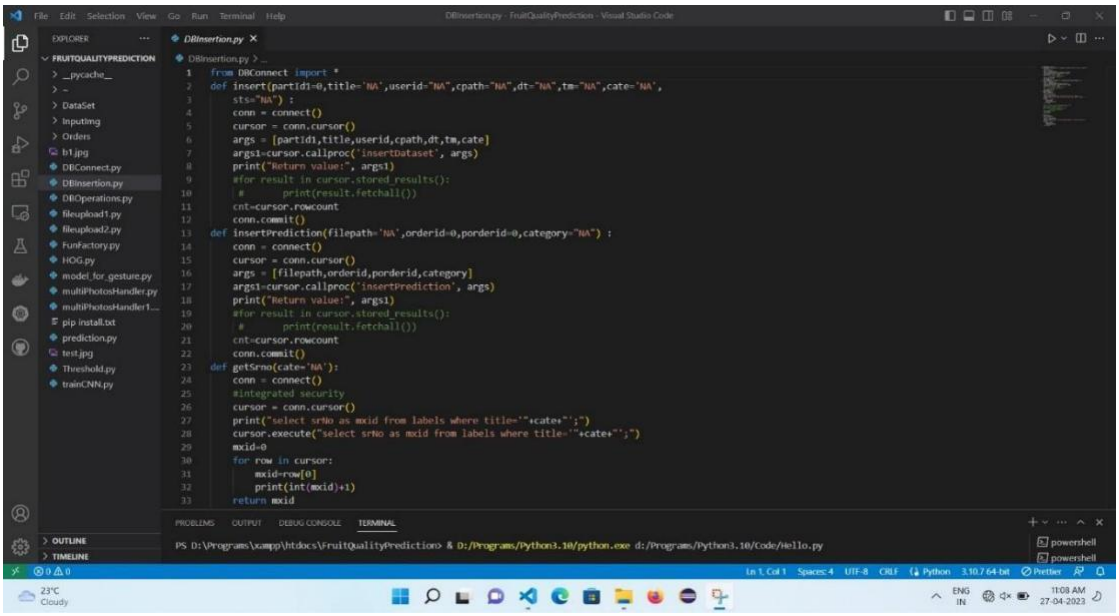


Fig 4.1 Database Insertion Code

- **DBoperation.py:** This component that is shown in the fig 4.2 is for operation database operation like DELETE,UPDATE,INSERT on the data.

  In DBOperation.py file contents all the information regarding code of data operation related configuration such as adding sellers and users to the database management system, where admin can have interaction with all the components we've designed for implementation of this project

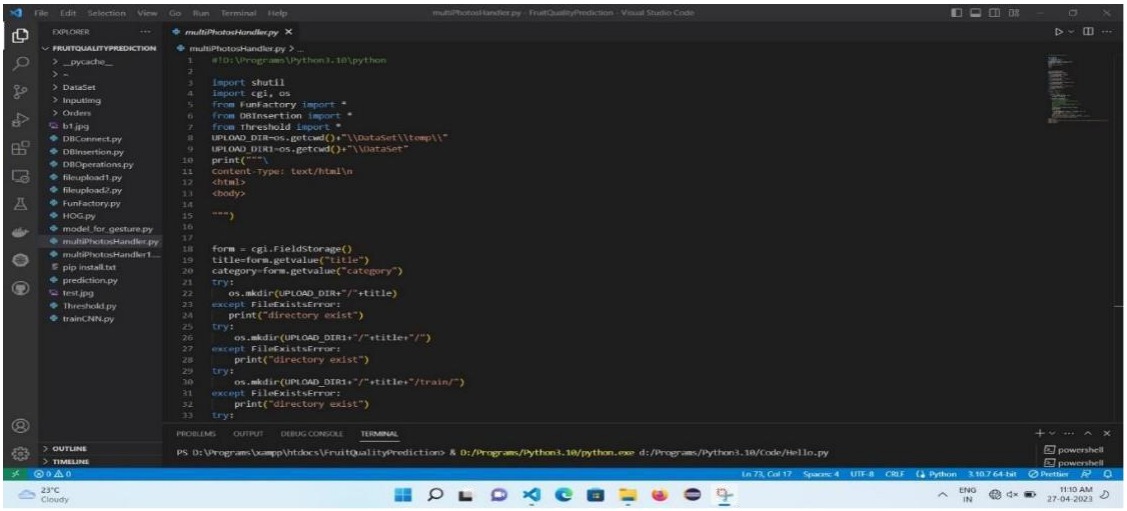


Fig 4.2 Database Operation Code

- **multiPhotosHandler.py:** This component that is shown in fig 4.3 is used for uploading the images on to the server and which is used for processing and learning purpose for the data models

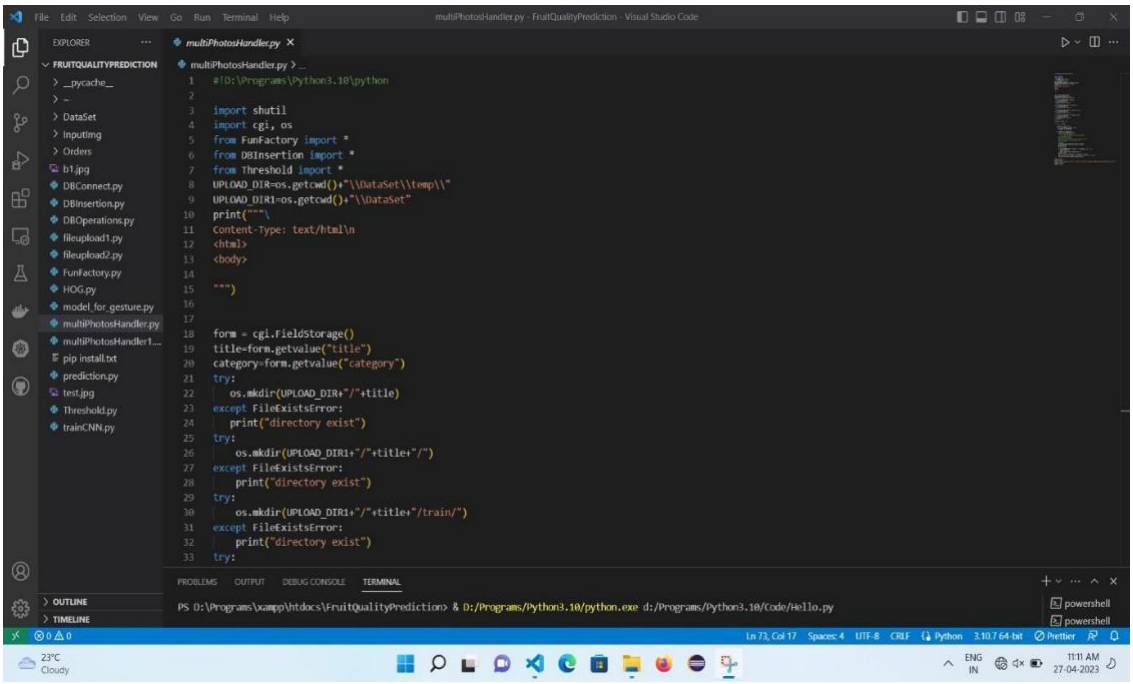


Fig 4.3 Multi Photos Handler Code

- **prediction.py:** This component that is shown in the fig 4.4 demonstrates use of CNN to train the data using various learning algorithms

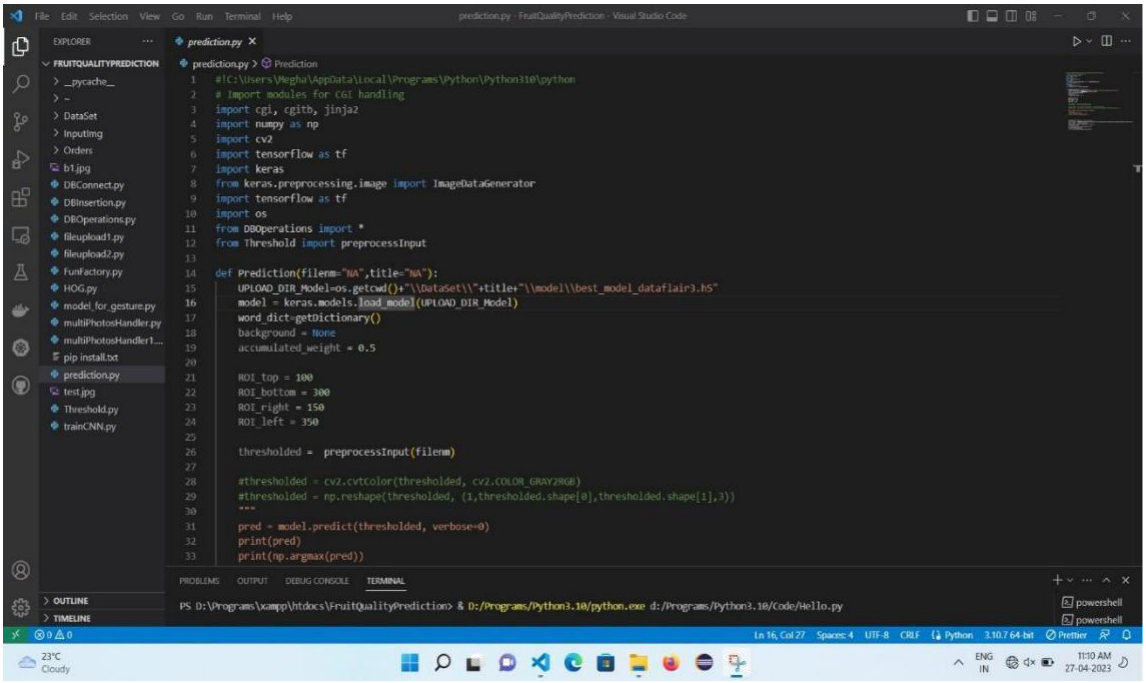


Fig 4.4 Price Prediction Code

- **trainCNN.py:** This component that is shown in the fig 4.5 is the main algorithm of training the CNN

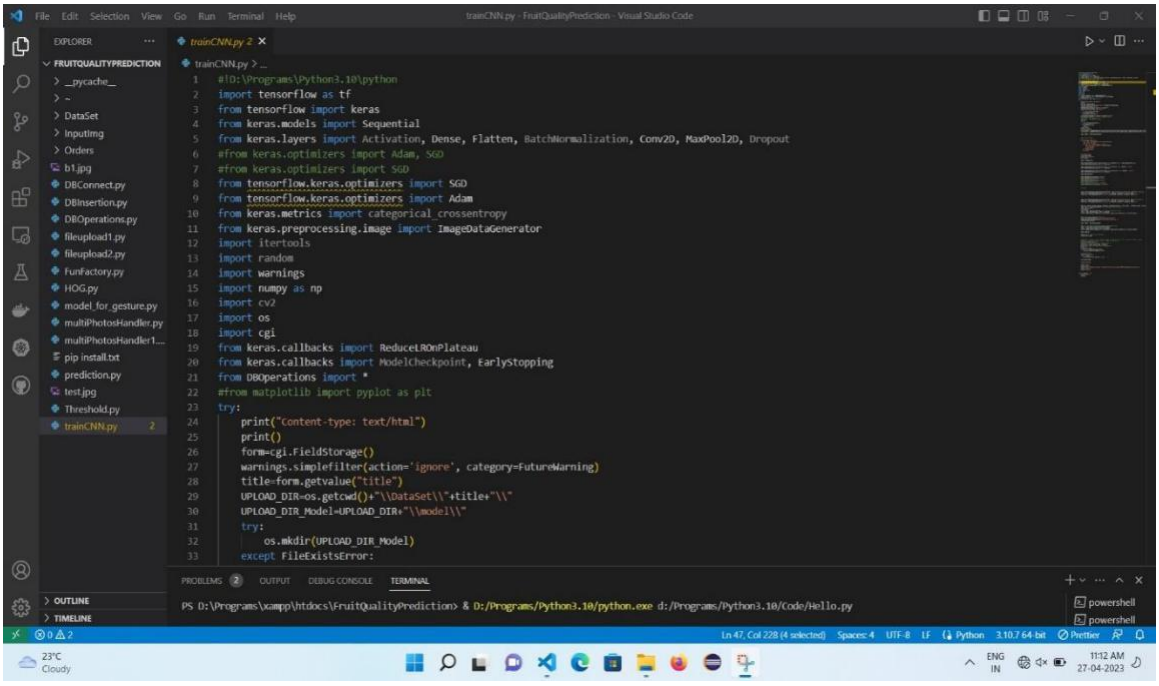


Fig 4.5 Train CNN Code

4.2 Testing

To find out the performance of the model, separate training data, testing data and validation data is created. The training dataset is used to train the model. During training time for checking the model performance validation set is used which helped tuning the hyper-parameters of the model. The test data is used to finding out the performance of final model. The dataset has total 2403 food images. Around 25% of images (569 in total) used for validation and 75% of images (1834 in total) used to train the model. After the training is completed, random images of fruit 5 in total is used. The validation data consisted of various fruit pictures. Test images that are referred from fig 4.6 can be seen below.

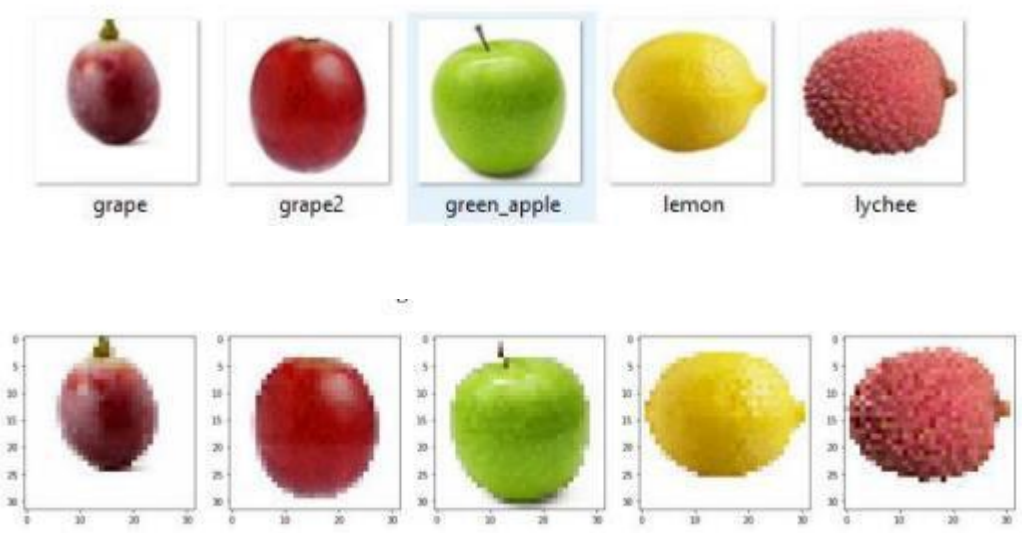


Fig 4.6 Computer Vision of the Validation data

To check the system validation, the images of validation data is used here. In this testing the model predicts the data which class it belongs to. During this type of testing, all of the images of validation data have to be cropped in 256×256 sizes.

Model performance

Subsequent to running 30 epochs the proposed model gained the accuracy of 99.84% for the training dataset that was created and 99.89% on the validation dataset. Completing the training session the test on random images went pretty well. The model was able to accomplish a very successive rate. Breaking down the outcome and confusion Matrix it can be assumed that the performance of this model is acceptable for these kinds of fruits. The over-all performance of the model is illustrated in figure 4.7.

In below referenced fig 4.7 (a), it indicates the training loss and validation loss of overall model performance. A very plain graph indicates the minimize loss for both training and testing of the model. Figure 4.7(b) shows the training accuracy and validation accuracy of the overall model performance. So the graph of figure 4.7 is pretty well for both loss and accuracy of training and testing of the model for datasets.

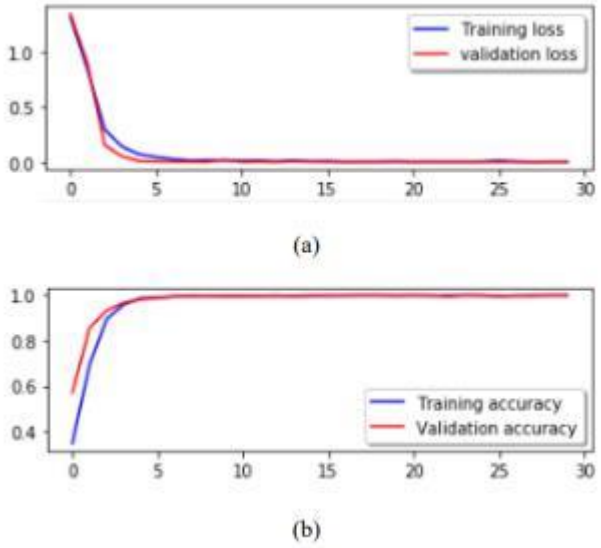


Fig. 4.7: (a) Loss of Training and Validation (b) Accuracy of Training and Validation

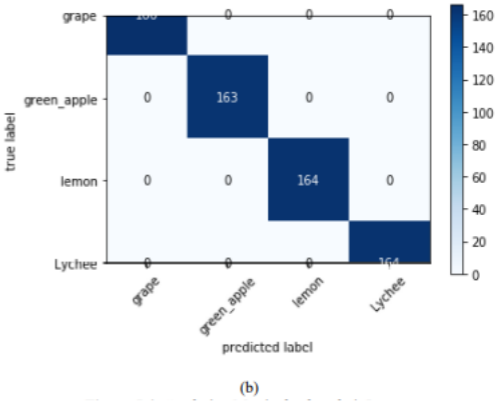
Confusion matrix

In terms of a classification model performance justification, confusion matrix (1) is widely used. It operates on a set of testing dataset where the true values are familiar. Figure 4.8 represents a drawing which is the confusion matrix for the proposed model. The entries in the matrix are True Positive (TP) rate, False Positive (FP) rate, True Negative (TN) rate, False Negative (FN) rate for each type of dataset. The accuracy is the division of the absolute number of predictions and the predictions . A confusion matrix is a table that is used to define the performance of a classification algorithm. A confusion matrix visualizes and summarizes the performance of a classification. algorithm. accuracy of the confusion matrix is accuracy of the confusion matrix is calculated by the following rules. In the below referenced fig 4.8, we can see that the true label and the predicted label are same for four classes. If the values of confusion matrix of four classes indicate the large numbers then it seems to be good results for the testing data.

$$\text{Accuracy} = \frac{(TP + TN)}{(TP + TN + FP + FN)}$$

```
Confusion Matrix
[[166   0   0   0]
 [  0 163   0   0]
 [  0   0 164   0]
 [  0   0   0 164]]
Classification Report
```

(a)



(b)

Fig. 4.8: Confusion Matrix

Model Summary

After training and testing the proposed model, the model can be summarized. The visualization of the model summary is given in The figure also shows the architecture of the proposed model which includes a lot of layers to implement the model. The convolution and max-pooling layers are used in feature extraction part and the dense and soft-max layers are used as the fully connected layer.

Chapter 5

DESIGN AND IMPLEMENTATION

5.1 Modules

The following mentioned below are the modules in this project. They combine to form the interface and also interact with each other. Some modules can only be accessed by the admin (administrator).

- **Admin Panel:** Admin panel is the main portal. Admin panel is also known as administration panel, it's a web based interface that allows authorized user to mange and monitor website, web application or software system.
- **Data Set Generation:** Dataset generation is the process of creating a set of data that is suitable for use in machine learning, artificial intelligence or data driven application.
- **Fruits Seller Panel:** This panel is used to show the information about the fruit seller, it is designed to manage sales, inventory and customer relationships
- **User Management:** The process of managing user account and access to resources in system or application. It knows modifying and deleting user accounts
- **Fruits Quality Detection:** It's the process using technology to evaluate the quality of fruit, technique used in computer vision techniques
- **Price Calculation:** This process determines the cost of product or service, using algorithms and business logic.

Admin Panel

The admin panel includes functions accessible to the administrator for maintenance of website.

- Login
- View fruit sellers
- View users
- Generate Dataset
  - Register fruits

- Upload fruits images for various types of quality

Data Set Generation

- Register Qualities
  - Fresh
  - Good
  - Normal
  - Rotten
  - Worst
- Upload fruit image: Uploading a fruit image for quality prediction is process where an image of a fruit is uploaded to a system that uses algorithm to predict the quality of the fruit
- Convert image into thumbnail: it used for quality prediction it resizes the image to smaller size while maintaining its aspect ratio, it is used to reduce size of image so that it can be displayed or process while still preserving the visual quality
- Convert it into gray scale: Converting the image to grey scale involves transforming the original image into a grey scale version where each pixel in the image is represented by single shade of grey
- Feature extraction: It is process of identifying and extracting meaningful features and patterns from raw data.
- Store features in database

Datasets registration: the admin has the right to register the information regarding the fruits and vendor this can be broadly elaborated in the fig 5.1

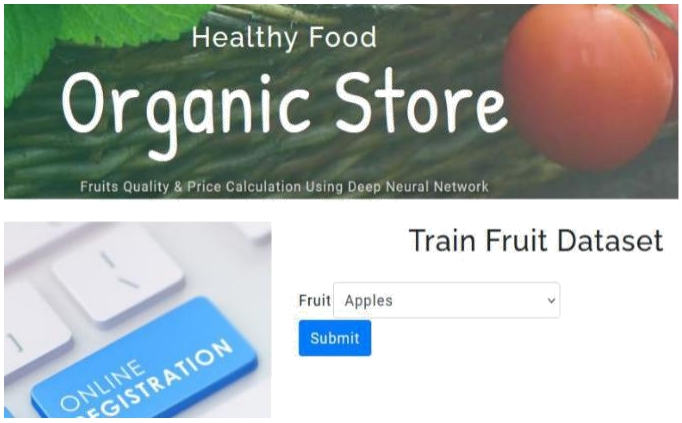


Fig 5.1 Dataset Registration

Fruits Seller Panel

- Register
- Login
- Upload Fruits to sell
- Update price
- Manage stock
- View pending orders
- Process orders
- View Fruit quality wise detected order price
- View ratings

Fruit seller panel: The fruit seller has to register the fruit and information which can be understood by the fig 5.2

Fig 5.2 Fruit Seller Panel

User Management: In user management components the user has various options of function which can be seen in the fig 5.3

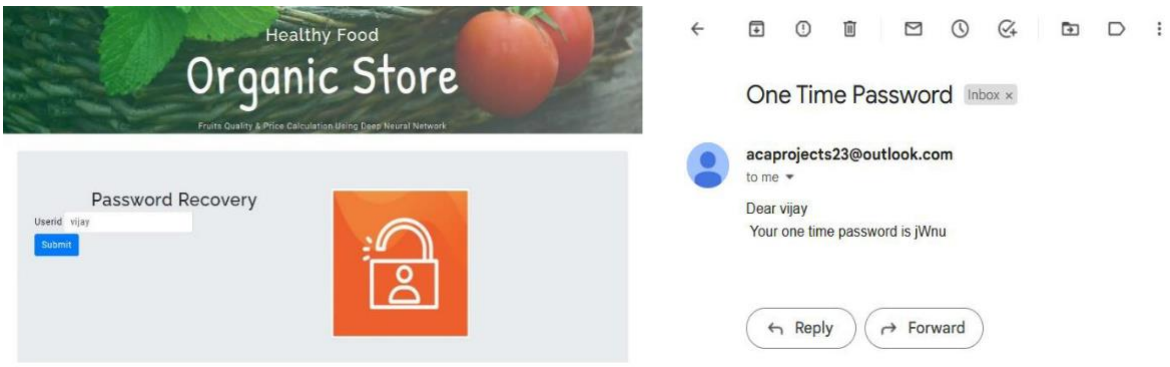


Fig 5.3 User Management

User Management

- Registration
- Login
- Change password
- Password recovery
- Browse fruit market online
- Place order
- View order details
- Upload fruits photos after receiving order
- Get calculated price

Fruits Quality Detection

- Upload fruit photo
- Fruit image preprocessing
- Feature extraction
- Quality detection using CNN algorithm

Price Calculation

- Quality detection of few fruits from the order
- Submit more information about the order
  - How many fruits are rotten and How many fruits are fresh? Etc.

Fruit Quality Prediction: In this segment we have predict the quality of the fruits based on CNN network, more details can be referenced from the fig 5.4

Fig 5.4 Fruit Quality and Price Prediction

5.2 System Architecture

- **Fruit Quality Detection**

  In this module, we will train CNN algorithm to detect fruit quality. Administrator will generate dataset and train CNN model.

- **DataSet Generation**

  Admin will upload category wise fruits images, our system will preprocess the images and store on python server. The system will train CNN and save the model on python server.

- **Fruits Quality Prediction**

  Following are the steps of classification:

  Image Acquisition: The first stage of any vision system is the image acquisition. After the image has been obtained, this technique uses all properties of elimination to increase features that can be obtained from the image. Each pixel contains information like intensity of light etc.

  Preprocessing: Pre-processing is in many cases concerned with taking one array of pixels as input and producing another array of pixels as output which in some way represents an improvement to the original array. This pre-processing step may remove noise, improve the contrast of the image, remove blurring caused by movement of the camera during image acquisition, it may correct for geometrical distortions caused by the lens.

  Segmentation: Another way of extracting and representing information from an

image is to group pixels together into regions of similarity. This process is commonly called segmentation. It is a process to find the object and separate it from the background image. And this process can be done by using Grey Scaling of Pre-processing step.

Labelling: Connected component labeling works by scanning an image, pixel-by-pixel (from top to bottom and left to right) in order to identify connected pixel regions. Connected component labelling works on binary or graylevel images and different measures of connectivity are possible.

Feature Extraction

Feature extraction a type of dimensionality reduction that efficiently represents interesting parts of an image as a compact feature vector. This approach is useful when image sizes are large and a reduced feature representation is required to quickly complete tasks such as image matching and retrieval. Feature detection, feature extraction, and matching are often combined to solve common problems such as object detection and recognition, content-based image retrieval, face detection and recognition, and texture classification.

Classification

Classification is a type of supervised learning. It specifies the class to which data elements belong to and is best used when the output has finite and discrete values. It predicts a class for an input variable as well.

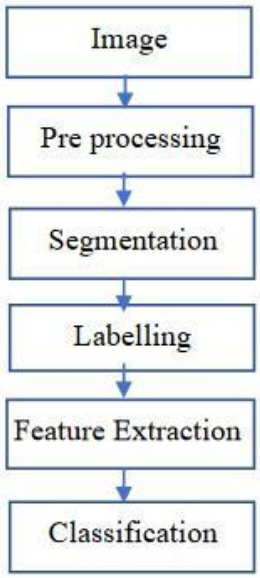


Fig 5.5 System Architecture Steps

- **Convolutional Neural Network**

In the above fig 5.5, Convolution neural network gets the input image and convert it into a 3-dimensional array of pixel values then a convolution layer is applied on the image to get the basic features using feature map and the max pooling is applied to the images to further decrease the dimension of the convolution layer then all the pixel values are flattened and are input as a neural network to learn the features like shape, size and color. The neural network learns the extracted features using gradient decent algorithm. After learning, the modal is capable of prediction the objects sent as input. Following Figure shows the architecture of convolutional neural network. It consists of three layers which are input layer, hidden layer and the output layer. The input is given in the input layer and the process of comparison and separation are done in the hidden layer. After the completion of separation process, output will be obtained in the classification layer.

- **Fruits Quality wise price calculation**

After Fruits quality prediction, our price calculation model will calculate the quality wise price of total purchased fruits and final cost will be displayed on screen. The customer will pay the amount displayed on screen not original. When user received the fruits order, he will divide the fruits into groups of different quality manually as per his opinion and then upload images of different quality fruits. No need to upload images of all the fruits, user will have to upload only one of the images from the manually created groups. Our quality prediction model will predict the quality of fruit by using uploaded fruit image, and then user will specify how many fruits are there similar to the uploaded image. On the basis of this data our fruits quality wise price calculation model will calculate the fruits price. The sample formula is as given below

E.g. User purchased 1 kg apples in which there are 6 medium size apples. Among 6 apples 1 apple is of worst quality, 3 apples are of moderate quality and 2 apples are of good quality then the price calculation formula will be Price of 1 kg apple =Rs. 60/-

Price of each apple=Rs. 10/-

Price of worst apple=Rs.3/- and

Price of Moderate quality apple =Rs. 7/-

Then total price of 1kg apples as per our model = (1*3) + (3*7) + (2*10)
=3+21+20=Rs. 44/-

- **Advantages**
  - Customer will be able to purchase the fruits in right price according to the quality
  - Seller fraud will get reduced
  - Easy to use

5.3 Implementation

1. Morphological features

The most common characteristics used for fruit classification are morphological characteristics, namely shape and size. Size is a physical dimension measurement that tells about the appearance of an object. Then, area, circumference, length of major and minor axes, and aspect ratio are usually used as morphological features. Morphological features are widely used in industrial automatic sorting purposes. Area is a scalar quantity which is the actual number of pixels in the region. Perimeter is a scalar quantity and it is the distance around the boundary of a region. The principal axis length is a scalar quantity that represents the principal axis length (in pixels) of the principal axis of the ellipse which has the same normalized second center moment as the area. The length of the minor axis is also a scalar that determines the length of the minor axis (in pixels) of the minor axis of the ellipse which has the same normalized second center moment as the area.

2. Texture feature

Texture represents the appearance of the surface and the distribution of elements. Texture is an important feature in predicting surfaces in terms of contrast, roughness, orientation, entropy, etc. Various techniques are used to describe the texture of an image. In a model-based approach, a set of parameters derived from the variation of pixel elements is used to define an image model such as the Gaussian Markov Random Field (GMRF), the fractional Brownian motion conditional probability of a particular pixel depending on the neighboring pixel values.

3. Color feature

The image has an RGB color model. The most common Color Model in image processing, is based on the primary colors red (R), green (G), blue (B). Basically,

for color features, each image is separated into red, green and blue fields, respectively, and through these fields, the mean, median, standard deviation are calculated. The NTSC or YIQ color space consists of three luminance components, which represent grayscale information, hue and saturation, which carry information from a signal.

4. Tensorflow

TensorFlow is programming library for machine learning applications such as neural networks. TensorFlow was developed by the Google Brain group for exploration and advancement of Google products. TensorFlow can run on multiple CPUs and GPUs in workspace conditions and is used in areas such as voice recognition, personal computer vision, mechanical technology, data recovery, and characteristic languages.

5. The Systemwork

The framework takes an image of the fruit with the camera, and the first step runs a tiny nervous system in TensorFlow to recognize whether the image is a natural product. The image is then passed to the TensorFlow neural system learning which can be seen in the fig 5.6

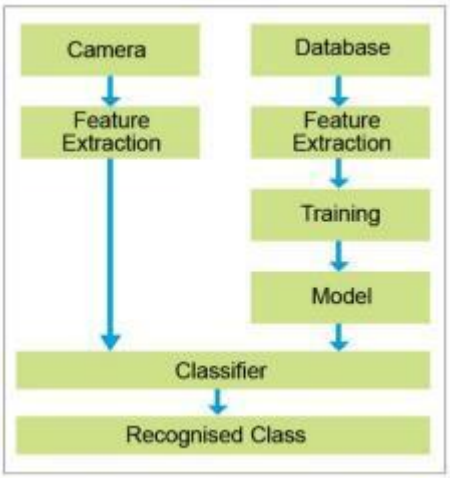


Fig 5.6 Block diagram of fruit recognition system

The TensorFlow code is a that alters the union, pooling, and arrange configuration to coordinate the number of classes and classes of pixels in the picture with minor alterations to the last layer. CNN places a convolutional layer and a pooling layer in the concealed layer between the info and yield layers.

In these two layers, the way of downgrading or testing the purpose of the image is repeated. The convolution layer applies weighted channels to a piece of image

information that may be useful for grouping, creating element maps. The union layer derives the element map by testing the most significant portion of the component map received from the convolution layer.

This reduces the size of the information while preserving the attributes, further prevents information discrepancies due to area changes and improves the appearance of the nervous system by reducing the size of the information. Given these removed highlights, grouping is performed.

6. Keras

Keras is a software library that provides a Python interface for artificial neural networks. Keras acts as an interface for the TensorFlow library.

7. Computer Vision

Computer vision is used to gather information from images captured from the real-time world and includes methods for image acquisition, processing, analysis, and understanding of images to gather symbolic and numerical information. Basically, the goal is to duplicate the effect of human vision by understanding, understanding and classifying images electronically. Computer vision is widely used in the post-harvest industry for quality inspection and fruit grading.

8. Transfer learning

Transfer learning is a popular method in computer vision for building accurate models in a time-saving manner. In computer vision, transfer learning is usually expressed through the use of a pre-trained model. A pre-trained model is a model that is trained on a large benchmark data set to solve a problem that is similar to the problem.

5.4 Working Details

1)Homepage: The home page is the landing page which can be seen in the fig 5.7. A home page is the default or front page of a site. It is the first page that visitors see when they load a URL.

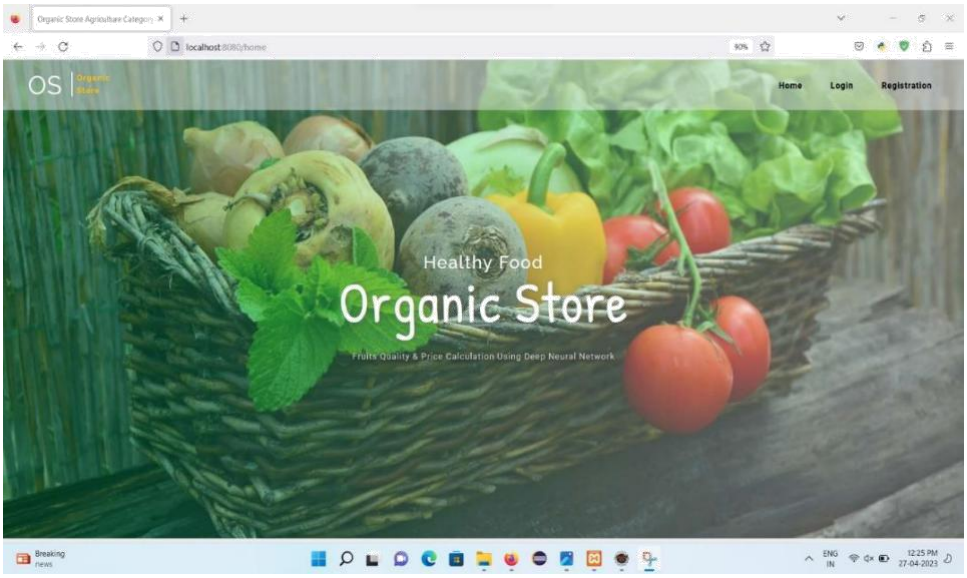


Fig 5.7 Homepage

2)Login Page: User can enter their details and submit it to the server as shown in fig 5.8. Login Page is used to allow the user's to login on the website and application. Applications/Websites identifies the users with their username and password. Login Page takes user input and passes the data to server-side program.

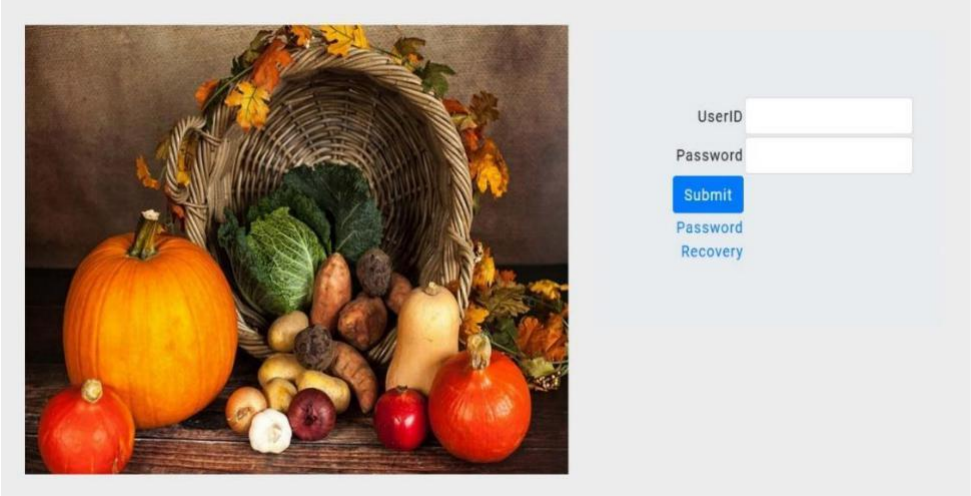


Fig 5.8 Login Page

3)Registration Page: This page is where the customer register themselves by filling their details in the as shown in fig 5.9. A signup page (also known as a registration page) enables users and organizations to independently register and gain access to your system. It is common to have multiple signup pages depending on the types of people and organizations you want to register.

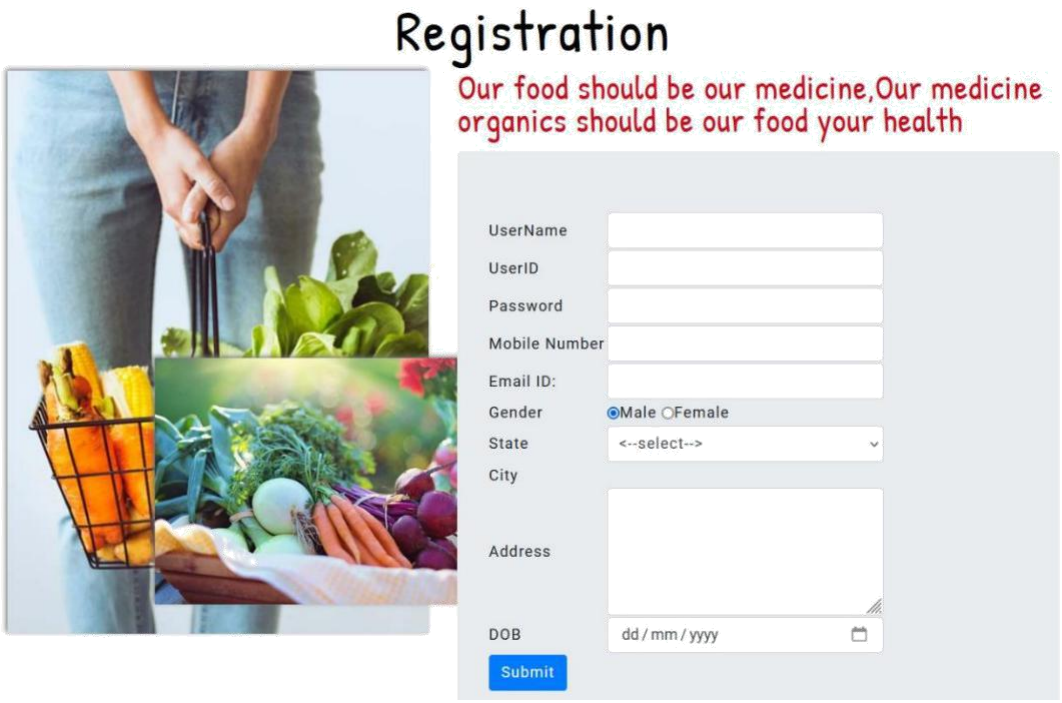


Fig 5.9 Registration Page

4)Seller Registration by Admin: Admin has the right to register seller on the platform which can be seen in the fig 5.10. Seller is verified by the administrator and then can sell his fruits on the website. This is done to maintain quality and trustability between the seller and customer.

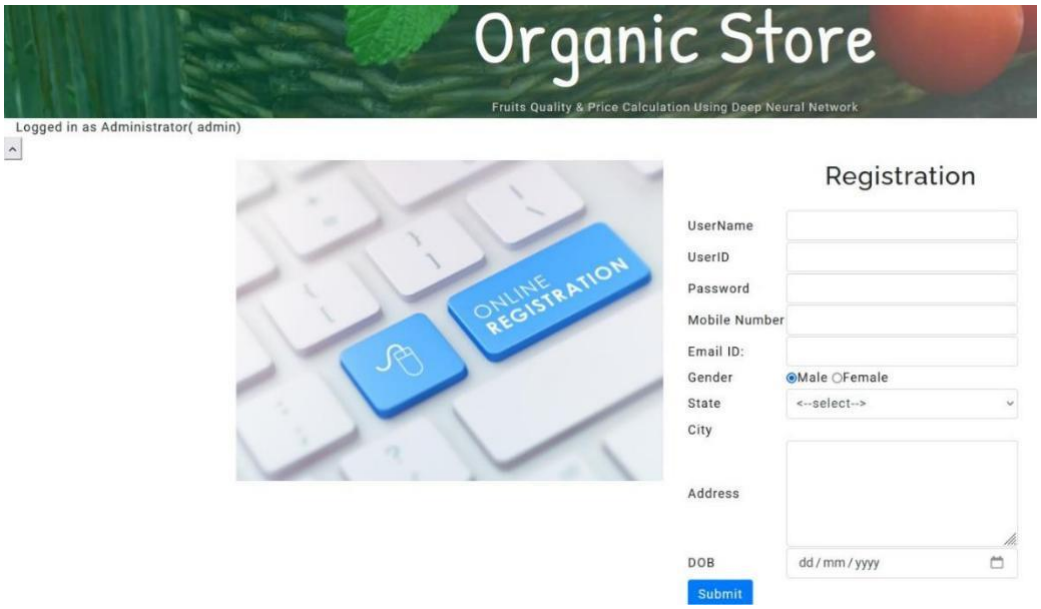


Fig 5.10 Seller Registration

5)Seller Add Products with Price: Seller can add products according to their prices as shown in fig 5.11

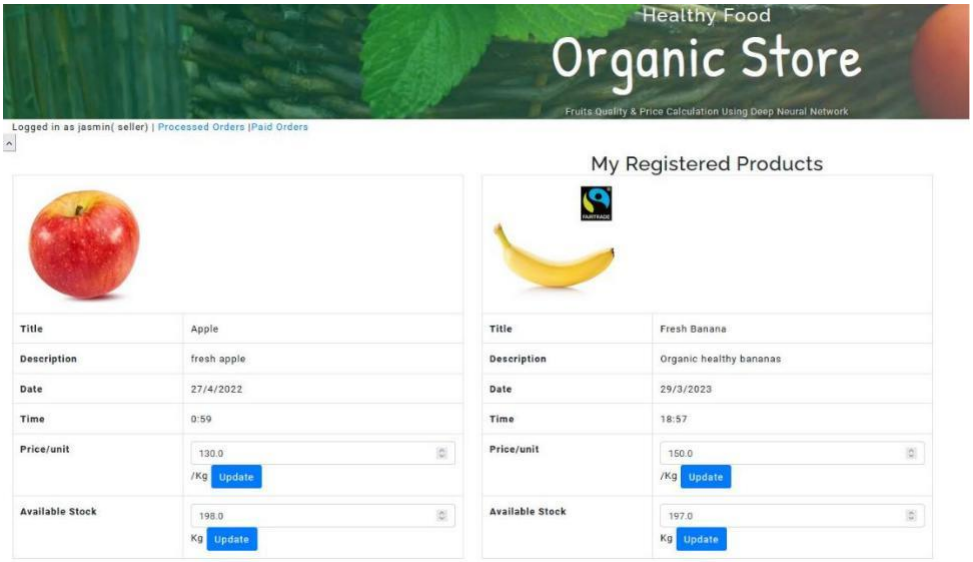


Fig 5.11 Seller and products with price

6)Orders: All the orders that are processed are shown in this page in the fig 5.12. Processed orders are then shown to the seller and he checks if stock is available and payment is processed.

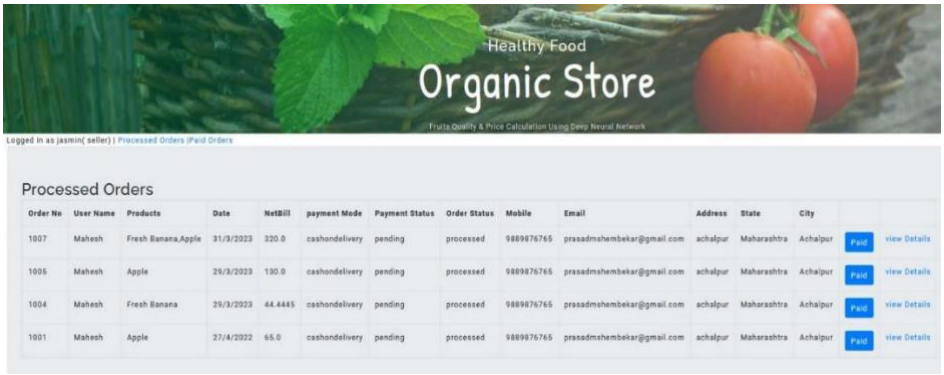


Fig 5.12 Orders

8)Price before prediction: Price before prediction are shown in this segment which can be seen in the fig 5.12.

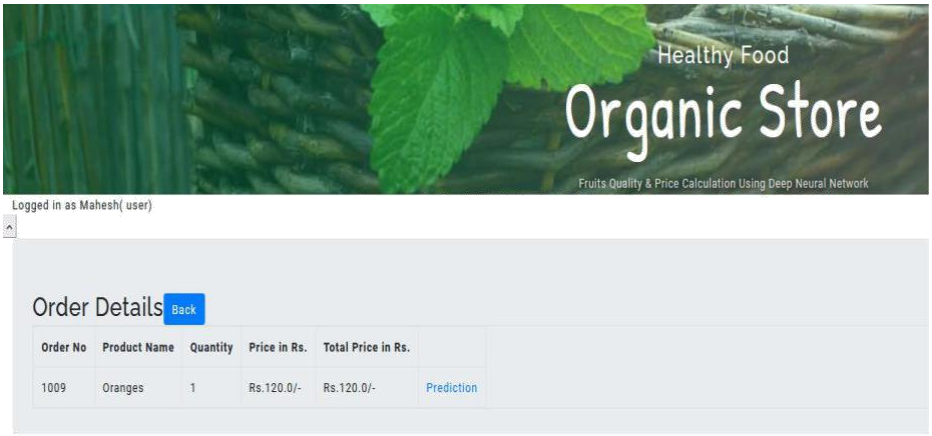


Fig 5.13 Price before calculation

9)New Price Generated: New price predicted by the algorithm are showcased here in the fig 5.14.

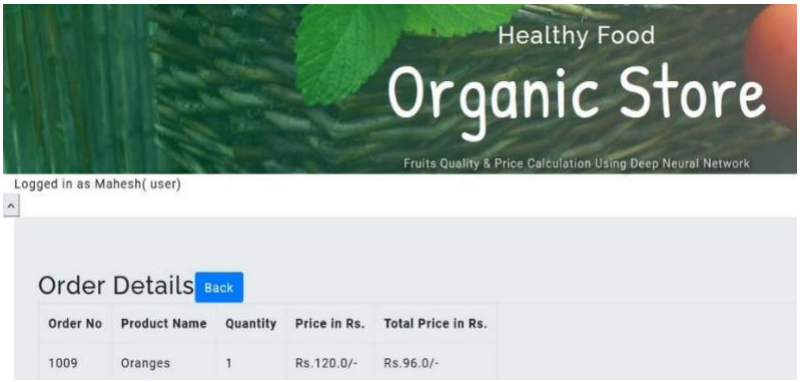


Fig 5.14 New Price Generated

Chapter 6

CONCLUSIONS AND FUTURE SCOPE

6.1 Conclusions

A new method for classifying fruits using a convolutional neural network algorithm has been carried out. In the proposed system, a model is introduced to recognize fruits from images. During this type of work, machine learning approaches have been developed to establish the model. In this study, a fruit dataset of 4 classes was introduced for introduction. To perform the model task, Convolutional Neural Network(CNNs) were used which were developed to carry out a machine learning approach. This model is able to get an accuracy of 99.89%, which proves that the performance of this model to recognize fruit from images is more advanced. The high accuracy of the model shows that CNN is very suitable for this kind of fruit recognition and also found a good algorithm for CNN which has been successfully implemented for fruit recognition. As we proposed dynamic dataset generation process, administrator will be able to increase the fruits types any time. Administrator has facility to train the dataset from web application. Therefore it is very easy for the administrator to handle dataset. We can conclude that our proposed system is very beneficial for customers.

- Improved accuracy in predicting fruit quality: A deep neural network can be trained on a large dataset of fruit images and associated quality scores to predict the quality of new fruit images. This could help to improve the accuracy of quality assessment and reduce the subjectivity of human judgement.
- Improved accuracy in predicting fruit prices: By training a deep neural network on historical data of fruit prices and factors affecting prices, such as seasonality, supply and demand, and quality, the model can predict the price of new fruit listings more accurately. This could help to optimize pricing and increase profitability for fruit sellers.
- Time and cost savings: Automating the quality and price assessment process using a deep neural network could save time and reduce the need for human intervention, leading to cost savings for fruit sellers.
- Increased customer satisfaction: Providing more accurate and consistent quality

assessments and pricing could increase customer satisfaction and loyalty.

- Scalability: The deep neural network model can be scaled to handle large datasets of fruit images and pricing data, allowing for the analysis of a wide range of fruit types and varieties.

6.2 Future Scope

In this project we proposed fruits quality prediction and quality wise price calculation system. For fruit quality prediction we proposed CNN algorithm. We proposed this system for fruits quality prediction but in future we will extend our scope to find out the quality of various vegetables and flowers also. Hopefully, in the future, the work can be extended with larger datasets having more fruit, flowers and vegetable categories. Have plans to implement several other CNN-based models to compare and further develop three-dimensional-based applications with augmented reality.

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